EPSRC
Engineering and Physical Sciences Research Council

Research Councils UK Energy For a Low Carbon Future

Energy Networks

Power Electronics for Distribution Network Optimisation

- Ground-breaking application of power electronics to enhance operation of electricity networks
- Control algorithms proven to optimise use of existing substation capacity and accommodate larger volumes of solar energy and electric vehicles
- Field trials of equipment in Brighton and London with UK Power Networks

Growth of electricity demand in urban areas, as land use becomes more intensive, has led to existing electricity networks of substations and underground cables running close to their capacity limits. In recent years, roof-top solar panels have spread quickly and electric vehicle charging points are becoming a more common sight on city streets. Continuing to support this growth is a huge challenge. Expanding the existing networks to cope is disruptive (such as digging trenches to lay fresh cables), slow (through acquiring sites for new substations) and expensive. A key research challenge has been to find means to exert more control over power flows and to optimise use of existing network assets to accommodate low-carbon technologies without that expense and disruption.

The Supergen HubNet consortium identified power electronics as a key technology for control and optimisation of power networks. To that end, we have core semiconductor research to improve power density and power efficiency, and we have also explored circuit configurations that make best use of the semiconductors in an electricity distribution network. From this emerged the innovative "soft open point", SOP, which gives controlled power flow through what were previously simple open/close switches. We have gone on to develop algorithms for control and strategies for deployment.

Case Study: Field Trials of Soft Open Points in London and Brighton

The idea of a soft open point for accommodating greater volumes of solar energy and electric vehicles was put forward in HubNet's forerunner, FlexNet by researchers at Imperial. Ricardo Energy and Environment worked with Imperial to propose that this technology should be trialled as part of OFGEM's Low Carbon Innovation Fund. This led, in 2014, to the £8.8m FUN-LV collaboration project with UK Power Networks, who have jointly worked to progress these technologies. Imperial College continued to refine control algorithms and transferred these to hardware supplier, Turbo Power Systems, who supplied 12 sets of two-way 240 kW SOPs and 12 three-way 400 kW SOPs. These have now been installed in substations and as street cabinets in London and Brighton and are streaming performance data. The data is being analysed by Imperial to assess effectiveness of the control strategy and to learn lessons on where and when to use this technology.

"HubNet research was the impetus for our FUN-LV project and it has been really helpful to have the research team working with us as development partners in the trials on our network"

David Boyer, Innovation Manager, UK Power Networks

Achievements:

- Decentralised control algorithms developed to use locally acquired data and reduce communications overhead
- Control algorithms translated into real-time software for deployment on industrial hardware.
- Type-testing of software and hardware at the Power Networks Demonstration Centre.
- First six months of field trial data analysed and control refinements proposed
- Further research questions over optimal deployment strategies and benefit quantification addressed, through a UK-China (EPSRC- NSFC) project
- Continued power converter circuit innovation through the grand challenge project for Top and Tail Transformation

EPSRC Outcomes Focus:

The following EPSRC outcome framework ambitions apply: R1 and R2

Resilient

Connected

Productive

Healthy

Academic partners:
Imperial College London, Cardiff University, Tianjin University (via EPSRC-NSFC Open Project), University of Nottingham

Industrial partners:
UK Power Networks, Ricardo Energy and Environment and Turbo Power Systems

The Supergen Programme, part of the Research Councils UK Energy Programme, led by the Engineering and Physical Sciences Research Council (EPSRC), aims to contribute to the UK's environmental emissions targets through a radical improvement in the sustainability of the UK's power generation and supply.

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